Claims

1. A method of treating a substrate material or film present on the material surface comprising cyclically performing the following steps:

(a) etching the material or film;

(b) depositing or forming a passivation layer on the surfaces of an etched feature; and

(c) selectively removing the passivation layer from the etched feature in order that the etching proceeds in a direction substantially perpendicular to the material or film surface,

wherein at least one of steps (a) or (b) is performed in the absence of a plasma.

2. A method according to claim 1, wherein step (a) is performed with one or more appropriate chemicals in the absence of a plasma.

3. A method according to claim 1 ~~or Claim 2~~, wherein the other of steps (a) and (b) is performed in the presence of a plasma.

4. A method according to ~~any one of claims 1 to 3~~ claim 1, wherein the material surface has previously had a mask pattern defined thereon.

5. A method according to ~~any preceding claim~~ claim 1, wherein the material or film is a dielectric.

6. A method according to Claim 5, wherein the material or film is an oxide, preferably of silicon, quartz, glass, pyrex, SiO_2 deposited by CVD, or SiO_2 grown by thermal, plasma or other means to deposit or grow the oxide.

7. A method according to ~~any preceding Claim~~ claim 1, wherein the material or film is etched with HF.

8. A method according to ~~any preceding Claim~~ claim 1, wherein H_2O and/or an alcohol is present in step (a).

9. A method according to ~~any one of claims 1 to 4~~ claim 1, wherein the material or film is a semiconductor, preferably a Si, SiGe or Ge semiconductor.

10. A method according to Claim 9, wherein the material or film is etched with HF, HNO_3 and CH_3COOH, or with a halogen containing compound, preferably an inter-halogen gas comprising halogen components only.

11. A method according to ~~any one of claims 1 to 4~~ claim 1, wherein the material or film is a conductor, preferably an Au or Pt conductor.

12. A method according to Claim 11, wherein the material or film is etched using aqua regia.

13. A method according to ~~any preceding Claim~~ claim 1, wherein N_2 or other inert gas is present in step (a) and/or is used as a purging gas between the steps of the method.

14. A method according to ~~any preceding Claim~~ claim 1, wherein the passivation layer is formed on a surface that is resistant to chemical etch.

15. A method according to ~~any preceding Claim~~ claim 1, wherein the passivation layer is deposited using a polymer.

16. A method according to Claim 15, wherein the polymer is of formula $n(C_xF_y)$, where x and y are any suitable values.

17. A method according to ~~any preceding Claim~~ claim 1, wherein, when a plasma is not present in step (b), a photo-enhanced polymerisation process is used in the deposition of the passivation layer.

18. A method according to ~~any preceding Claim~~ Claim 1, wherein the selective removal of the passivation layer is carried out by surface irradiation.

19. A method according to Claim 18, wherein the irradiation is thermal heating of either the front and/or the rear surface of the material or film to provide thermolytic decomposition, or is provided by a light source on the front of the material or film resulting in photolytic decomposition, or wherein the irradiation source is an excimer laser.

20. A method according to Claim 18 ~~or Claim 19~~, wherein the irradiation is directional or collimated parallel to the direction of etch front propagation.

21. A method according to Claim 18, wherein the surface irradiation is a plasma, wherein the ion energy in the plasma is preferably greater than 10eV.

22. A method according to Claim 21, wherein the plasma comprises a precursor gas or mixture of precursor gases.

23. A method according to Claim 22, wherein the precursor gas comprises an inert gas which is capable of physically removing the passivation layer and/or a gas which is capable of physically removing the passivation layer with chemical enhancement.

24. A method according to Claim 22 ~~or 23~~, wherein the precursor gas comprises an etchant chemical used in step (a) or a material used for depositing the passivation layer in step (b).

25. A method according to ~~any preceding Claim~~ Claim 1, wherein any gases employed are delivered from a point of use delivery system positioned locally to a chamber within which the method is

performed.

26. A method according to ~~any preceding Claim~~ Claim 1 for treating a substrate material or film formed from metallic and magnetic materials, wherein the process is operated at pressures above atmosphere and/or at elevated temperatures using as etchant materials any one or more of diketones, ketoimines, halogenated-carboxylic acid, acetic acid, and formic acid chemistries and extensions including hexafluoro-2,4-pentanedione and other fluorinated acetyl-acetone groups.

27. An apparatus for performing the method of ~~any preceding~~ Claim 1 Claim, the apparatus comprising a chamber having a chemical inlet and a chemical outlet in which is positioned a support for receiving a substrate, the apparatus further comprising means for etching a substrate material or a film present on the material surface with one or more appropriate chemicals, means for depositing a passivation layer on the surfaces of an etched feature, and means for selectively removing the passivation layer from the etched feature in order that the etching proceeds in a direction substantially perpendicular to the material or film surface.

28. An apparatus according to Claim 27, wherein the support is in the form of a first electrode and preferably also a second electrode is spaced from the first electrode.

29. An apparatus according to Claim 28, further comprising means for providing RF energy or microwave energy to a plasma in the chamber.

30. An apparatus according to ~~any one of Claims 27 to 29,~~ Claim 27 further comprising means for providing an electrical bias on to

the support to accelerate ions onto the substrate for at least part of the cycle.

31. An apparatus according to ~~any one of Claims 27 to 30,~~ Claim 27 further comprising means for providing radiation energy into the chamber, and/or means for controlling the substrate temperature, and/or means for rotation for enhancing the homogeneity of the etching.

32. An apparatus according to ~~any one of Claims 27 to 31,~~ claim 27 wherein the means for etching the substrate, means for depositing the passivation layer and means for selectively removing the passivation layer are associated with a single chamber.

33. An apparatus for performing the method of ~~any one of Claims 1 to 26,~~ Claim 1 the apparatus comprising means for etching a substrate material or a film present on the material surface with one or more appropriate chemicals, means for depositing a passivation layer on the surfaces of an etched feature, and means for selectively removing the passivation layer from the etched feature in order that the etching proceeds in a direction substantially perpendicular to the material or film surface wherein each of the means for etching, means for depositing the passivation layer and means for selectively removing the passivation layer are associated with the same or a separate chamber in which the substrate is positioned.

34. A method of delivering a vapour into a chamber for etching a substrate positioned therein, the method comprising:

(a) feeding a solution into the chamber by creating droplets on or before entering the chamber; and

(b) generating an electrostatic field to electrostatically attract the droplets to the substrate, thereby etching the substrate.

35. A method according to claim 34, wherein the droplets are provided with a positive or negative charge on or before entering the chamber, preferably created by means of a high voltage power supply connected to a droplet inlet point into the chamber, the substrate then optionally being positioned on an electrode which is grounded with respect to the high voltage power supply.

36. A method according to claim 34 ~~or Claim 35~~, wherein the strength of the electrostatic field is in the range of 2 to 30kV/mm.

37. A vapour delivering apparatus comprising a dielectric body within which are positioned a plurality of nozzles, each nozzle extending from the back side of the body to the front side, wherein the body is metallized to form a continuous electrical path between the back side and the inside of each nozzle to the tip thereof.

38. A vapour delivering apparatus according to claim 37, further comprising electrical connections from a power supply to the metallized part of the body, and wherein optionally different areas of the body are connected to a power supply to create a varying electric field across the body.

39. A method of treating a substrate according to Claim 1 and substantially as hereinbefore described with reference to the accompanying drawings.

40. An apparatus substantially as hereinbefore described with reference to, and as illustrated in, the accompanying drawings.